

INDOOR AIR QUALITY ASSESSMENT

**Hadley Elementary School
24 Redington Street
Swampscott, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of a parent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Hadley Elementary School (HES), 24 Redington Street, Swampscott, MA.

On March 6, 2002, Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an indoor air quality assessment. Mr. Holmes was accompanied by Danny Cahill, School Maintenance Supervisor, James Marrotta, Director of the Swampscott Health Department and Principal Lois Longin for portions of the assessment.

The school is a three-story red brick building with basement constructed in 1911. A three-story annex was added in 1915 connected to the original building by an enclosed corridor (see Picture 1). The 1911 building contains general classrooms, computer room, library, teachers lounge, gymnasium/auditorium, main office and nurse's station and a combination art/music room. The annex contains general classrooms, kindergarten, occupational therapy room, cafeteria and offices.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content of wall plaster was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The school houses kindergarten through fifth grades with a student population of approximately 280 and a staff of 30-35. Tests were taken under normal operating conditions and results appear in Tables 1-5.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in sixteen of thirty-three areas surveyed, indicating inadequate air exchange in some areas.

Original 1911 Building

Ventilation in the 1911 building was originally provided by a forced hot air system. This system was intentionally abandoned and replaced by a mechanical ventilation system. Fresh air in classrooms is currently supplied by a unit ventilator (univent) system (see Picture 2). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 3) and return air through an air intake located at the base of each unit ([see Figure 1](#)). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit.

Univents were deactivated in a number of classrooms surveyed (see Tables). Obstructions to airflow, such as books, papers and posters on top of univents, as well as bookcases, tables and desks in front of univent returns, were seen in a number of classrooms (see Pictures 2 & 4). To function as designed, univents and univent returns

must remain free of obstructions. Importantly, these units must be activated and allowed to operate during hours of school occupation.

Mr. Cahill reported that the school currently has no operating mechanical exhaust system. The original gravity system was abandoned and rooftop equipment was removed and sealed. It is reportedly planned for the Swampscott School Department's (SSD) ventilation consultant to install a modern mechanical exhaust system within the next few months. The addition of the mechanical exhaust system in combination with the operation of univents would be expected to improve ventilation and increase airflow.

1915 Annex Building

The annex has univents of two different vintages. The annex building's third floor classrooms are ventilated by univents similar to those installed in the original building. Third floor univents were operating during the assessment. The first and second floors of the annex building are equipped with univents originally installed during the construction of the annex. These 1915 univents are not used (see Picture 5).

The annex does not contain an operating mechanical exhaust system. Without exhaust ventilation, environmental pollutants can build up in the indoor environment and lead to indoor air quality complaints. Mr. Cahill reported that the SSD plans to install six univents within the next year in the annex and consideration is also being given to installing a mechanical exhaust system. Until mechanical supply and exhaust ventilation components are installed, classrooms are ventilated via open windows.

Some classrooms are equipped with window-mounted air conditioners (WAC). These units have a "fan only" option (see Picture 6), which introduces outside air without conditioning it. Classrooms without functioning univents should utilize these WACs to supplement open windows to provide fresh air.

The cafeteria is equipped with a ceiling-mounted univent for fresh air and a local mechanical fan to exhaust air (see Picture 7). This equipment is reportedly not operated during periods of occupancy. BEHA staff recommended to school maintenance staff that the ventilation equipment be operated during periods of cafeteria occupancy.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated

temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches (see Appendix I).

Temperature readings ranged from 67° F to 77° F, which were below the BEHA recommended comfort guidelines in some areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. Temperature complaints were expressed in a number of areas, which can also indicate problems with the ventilation system and/or thermostatic control. In addition, temperature control is difficult in older buildings with abandoned or nonfunctioning ventilation systems. Spaces beneath a door to the outdoors on the roof were noted in Ms. Remare's room (see Picture 8). These spaces can allow drafts and moisture to enter into the classroom making it further difficult to control temperature. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity ranged from 23 to 33 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity in these buildings would be expected to drop below comfort levels during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Water-damaged ceiling tiles and wall plaster were observed in several areas of both buildings, which may indicate either a current or historic water penetration problem. Efflorescence (i.e., mineral deposits) and peeling paint were observed above the ceiling tiles in the coatroom of Ms. Salemi's classroom (see Pictures 9 & 10). Efflorescence is a characteristic sign of water damage to building materials such as brick or plaster, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, water evaporates, leaving behind white, powdery mineral deposits. This condition indicates that water from the exterior has penetrated into the building. Water-damaged building materials, such as painted wall plaster and ceiling tiles, can serve as a medium to support mold growth, especially if wetted repeatedly. This was reported to be an area of chronic water penetration. It was reported that the brickwork of the exterior wall of the building was repointed to prevent further water damage. BEHA staff conducted moisture testing of wall plaster in this area. No elevated moisture levels or visible mold growth were observed in walls with efflorescence at the time of the assessment.

Plants were noted in several classrooms. Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold.

Caulking/weather stripping around window panes in Ms. Palleschi's classroom was failing (see Picture 11). Water penetration through windows/frames can lead to mold

growth under certain conditions. Replacement of caulking and repairs of window leaks are necessary to prevent further water penetration.

Around the perimeter of the building small trees/stumps and other plants were growing in the tarmac/exterior wall junction (see Picture 12). The growth of roots against the exterior walls as well as spaces between the tarmac and exterior walls of the building can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Spaces can bring moisture in and eventually lead to cracks and/or fissures in the foundation.

Other Concerns

Several other conditions were noted during the assessment that can affect indoor air quality. Exposed fiberglass insulation was observed around univents in a number of classrooms (see Picture 13). Fiberglass insulation can be a source of skin, eye and respiratory irritation to sensitive individuals.

The rear right corner of the auditorium contained a lamination machine, photocopier and other equipment (see Picture 14). Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Lamination machines can produce irritating odors during use. This area is not equipped with local exhaust ventilation to remove excess heat and odors generated by this equipment. The opposite side of the auditorium (rear left) has a wall-mounted exhaust vent. Once the building is provided with mechanical exhaust ventilation, the equipment should be re-located to this area.

Accumulated chalk dust was noted in several classrooms (see Picture 15). Chalk dust is a fine particulate, which can become easily aerosolized and serve as a source of eye and respiratory irritation. A number of classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999). Cleaning products were found on floors, counter-tops and beneath sinks in a number of classrooms. Cleaning products and dry erase board markers and cleaners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

Also of note was the amount of materials stored inside classrooms. In several areas, items were observed piled on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. For this reason, items should be relocated and/or cleaned periodically to avoid excessive dust build up.

A number of univents had accumulated dirt, dust and debris within their air handling chambers, on coils, fans and other components (see Picture 16). These conditions can be attributed to the fact that no means for inserting filters exist in these univents. In order to avoid univents serving as a source of aerosolized particulates, the air handling sections of the univents should be regularly cleaned. However, without filters, dirt, dust and debris can easily collect within the units.

Conclusions/Recommendations

The solution to the indoor air quality problem at the Hadley Elementary School is somewhat complex. The combination of the general building conditions, maintenance, work hygiene practices and the condition (or lack) of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term** measures should be considered for immediate implementation:

1. Continue with plans to install univents in all non-mechanically ventilated classrooms. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.
2. Remove all blockages from univents to ensure adequate airflow. Clean out interiors of univents regularly.
3. Operate cafeteria univent and exhaust vent during periods of occupancy.
4. Continue with plans to provide both the original 1911 building and 1915 annex building with mechanical exhaust ventilation.

5. To maximize air exchange, the BEHA recommends that the ventilation system operate continuously during periods of school occupancy independent of classroom thermostat control.
6. If the original mechanical ventilation system or ductwork/chimneys are not utilized to provide mechanical ventilation, ensure abandoned shafts/vents are properly sealed to eliminate pathways for movement of odors and particulates into occupied areas.
7. Regulate airflow in classrooms by using openable windows to control for comfort. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding. Service/repair windows in the building that are difficult to operate (see Tables).
8. Operate WACs in the “fan only” mode in classrooms without operating univents to provide fresh air.
9. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
10. Ensure exhaust ventilation shafts are properly secured with screens on the roof of the original building. Inspect periodically to prevent occupation by birds and other pests.

11. Repair/replace window weather stripping/caulking in Ms. Remare's classroom.
12. Remove plants from univents. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Regularly inspect all roof and exterior drains to ensure proper drainage.
13. Remove plant growths against the exterior wall/foundation of the building to prevent water penetration.
14. Consider relocating photocopiers and lamination machines to opposite side of auditorium once mechanical ventilation is activated.
15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
16. Encapsulate exposed fiberglass insulation around univents and pipes to avoid the aerosolization of fiberglass fibers.
17. Store chemicals and cleaning products properly and out of the reach of students.
18. Clean chalkboards and trays regularly to prevent the build-up of excessive chalk dust.
19. Remove accumulated mineral deposits from above ceiling tiles in Ms. Salemi's coat closet/room. Monitor this area periodically for water penetration.

The following **long-term measures** should be considered:

1. Based on the age, physical deterioration and availability of parts for ventilation components, the BEHA strongly recommends that an HVAC engineering firm fully evaluate the ventilation systems of both buildings.

2. Examine the feasibility of providing mechanical supply and exhaust ventilation in the original building. Determine if existing airshafts, vents, ductwork, etc. can be retrofitted for (modern) mechanical ventilation.
3. Thermostat settings throughout the school should be evaluated. Thermostats should be set at temperatures to maintain comfort for building occupants.
4. Repair any existing water leaks and replace any remaining water-stained ceiling tiles, wooden windowsills and wood trim. Examine the areas above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
5. If necessary, consider having exterior brick repointed and waterproofed to prevent further water intrusion. Repair/replace water-damaged plaster. Examine surrounding non-porous areas for mold growth and disinfect with an appropriate antimicrobial if necessary.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0.

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

Picture 1



Hadley Elementary School 1911 and Smaller Annex Building 1915

Picture 2



Example of Classroom Univent Retrofitted into 1911 Building and in 3rd Floor of Annex

Picture 3



Univent Fresh Air Intake

Picture 4



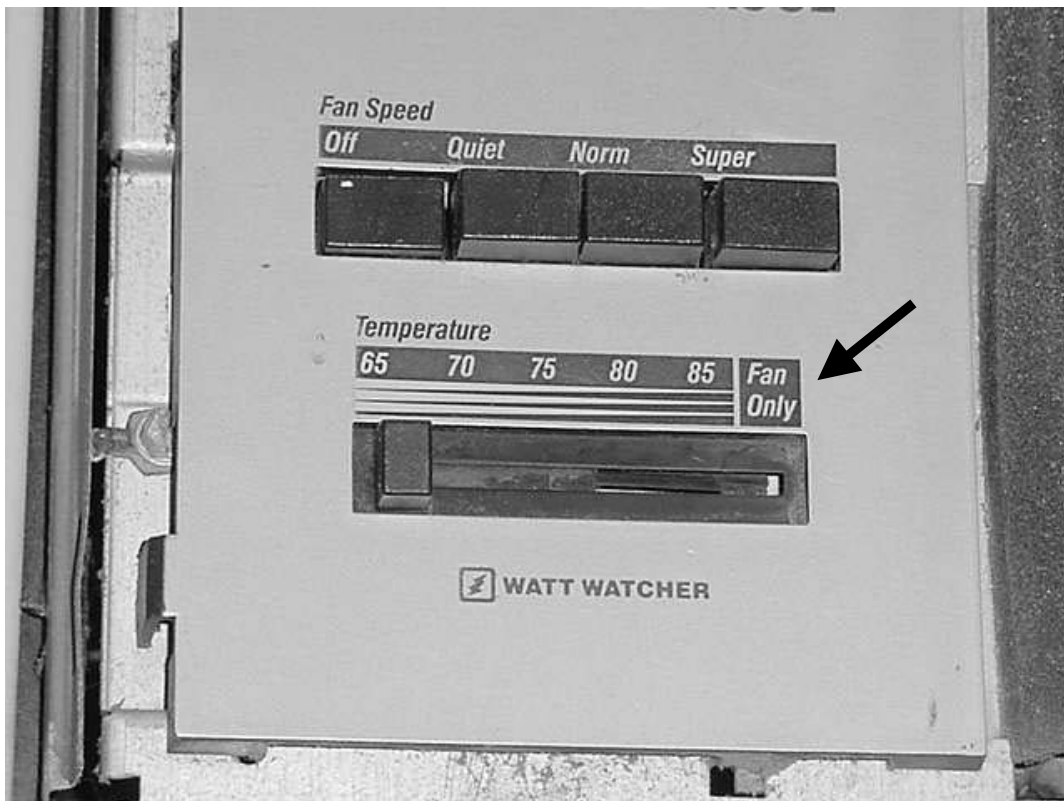
Univent Airflow Obstructed by Barriers in Front of Unit as Well as on Either Side

Picture 5



1915 Univent in Annex Building

Picture 6



Control Panel for Window-Mounted AC; Note “Fan Only” Setting

Picture 7



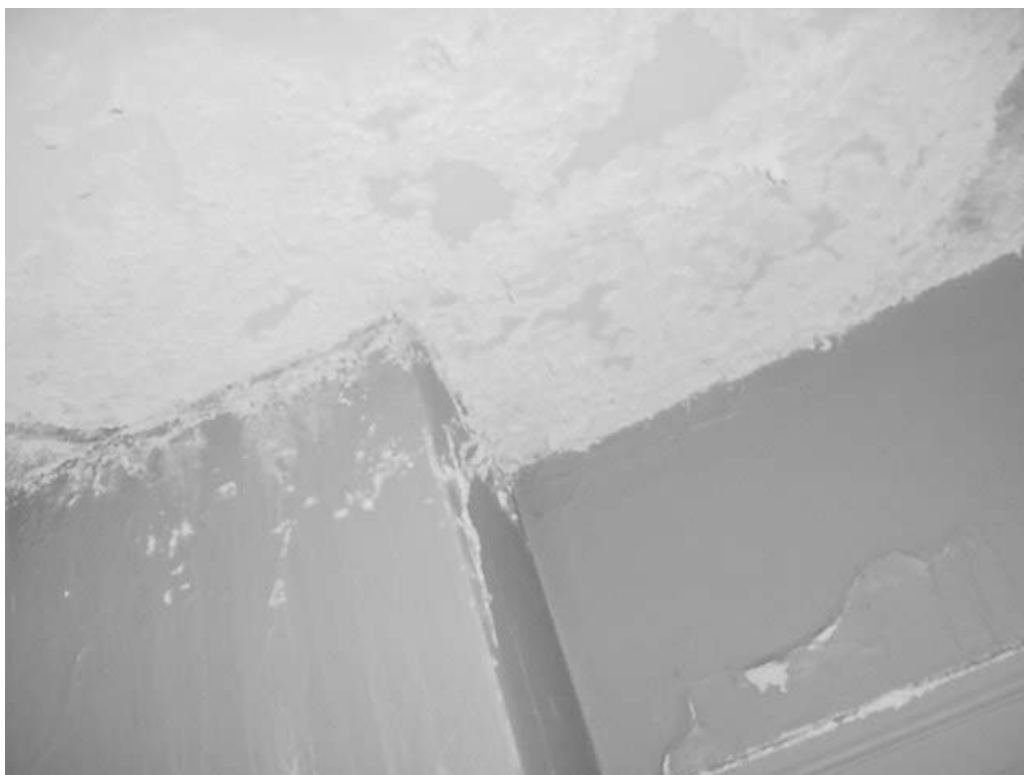
Local Exhaust Fan in Cafeteria

Picture 8



Space beneath Door to Roof in Ms. Remare's Room

Picture 9



Peeling Paint and Water-Damaged Ceiling Plaster above Ceiling Tiles in Ms. Salemi's Coat Closet

Picture 10



Accumulated Mineral Deposits from Water-Damaged Ceiling Plaster above Ceiling Tiles in Ms. Salemi's Coat Closet

Picture 11



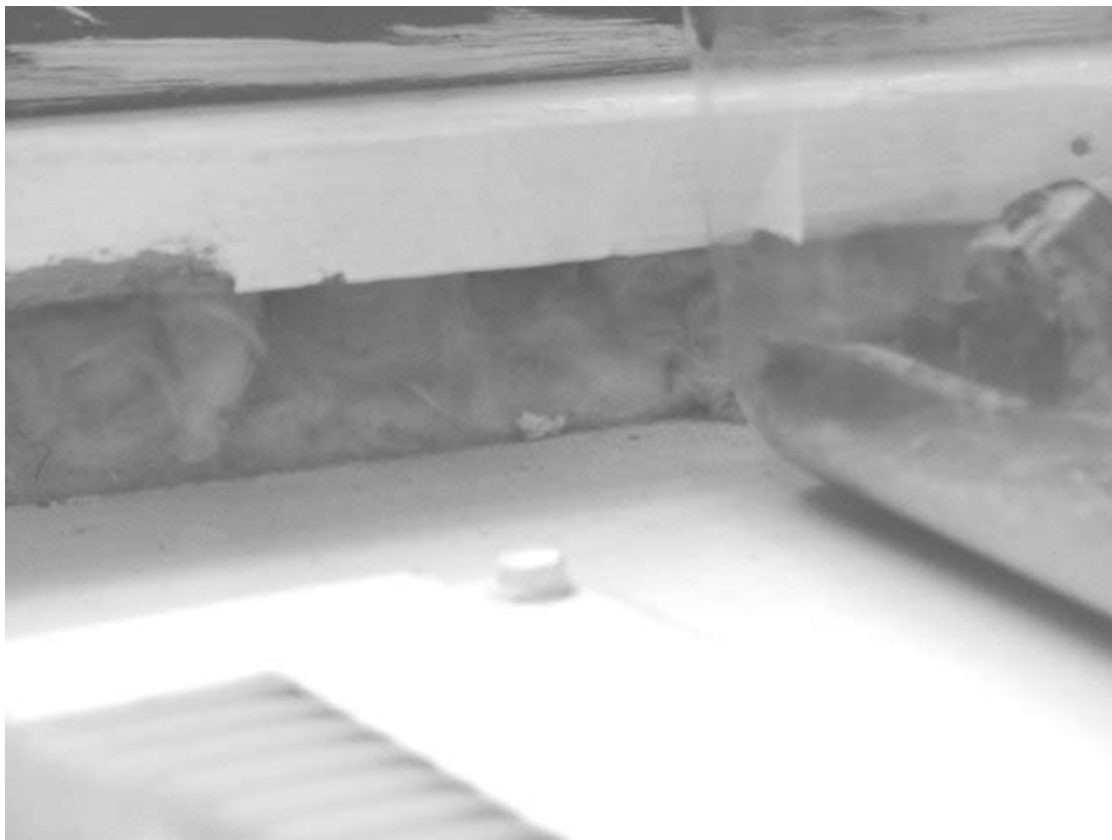
Failing Caulking/Stripping in Ms. Palleschi's Classroom

Picture 12



Small Trees Growing against the Foundation of the Building

Picture 13



Exposed Fiberglass around Classroom Univent

Picture 14



Photocopiers and Lamination Machines in Rear of Auditorium

Picture 15



Accumulated Chalk Dust in Classroom

Picture 16



Trash and Debris inside Univent Air Diffuser near Heating Element

TABLE 1

Indoor Air Test Results – Hadley Elementary School, Swampscott, MA – March 6, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|--------------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 389 | 55 | 31 | | | | | |
| Remare | 991 | 72 | 27 | 0 | Yes | Yes | Yes | Chalk dust, space under exterior door, paper in univent |
| Palleschi | 1440 | 71 | 29 | 21 | Yes | Yes | Yes | Items on univent, exposed fiberglass around air conditioner, failed stripping around windows |
| 3 rd Floor Restroom | | | | | | | Yes | |
| Computer room | 680 | 71 | 23 | 0 | Yes | Yes | Yes | 2 water-damaged CT, 20+ computers, |
| Randall | 1354 | 70 | 25 | 21 | Yes | Yes | Yes | Items on univent |
| Palardy | 1050 | 70 | 24 | 19 | Yes | Yes | Yes | Dry erase board-particulate, door open, 1 water damaged CT-corner |
| Salemi | 634 | 69 | 25 | 4 | Yes | Yes | Yes | Historic water damage above CT in coat closet-efflorescence/peeling paint |
| Katz/Richard | 635 | 70 | 24 | 4 | Yes | Yes | Yes | |
| Smith/Dineen | 505 | 69 | 23 | 1 | Ys | Yes | Yes | |

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Hadley Elementary School, Swampscott, MA – March 6, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|----------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| Teacher's Room | 1200 | 71 | 24 | 7 | Yes | No | No | |
| Bathroom | 580 | 69 | 24 | | Yes | Yes | | No exhaust vent, window open, stick-up air freshener |
| Library | 780 | 71 | 23 | 1 | Yes | Yes | Yes | |
| Toner | 1300 | 72 | 28 | 21 | Yes | Yes | Yes | 3 plants, dislodged CT-exposed fiberglass |
| Gilbert | 791 | 71 | 25 | 0 | Yes | Yes | Yes | 8 plants, missing CT-near door-exposed fiberglass |
| Citino | 1673 | 71 | 29 | 17 | Yes | Yes | Yes | Univent off-accumulated debris inside, exposed fiberglass-univent pipe, door open |
| Farley | 1588 | 71 | 30 | 3 | Yes | Yes | Yes | Univent off/obstructed-items on/in front of univent |
| Gym | 1007 | 71 | 27 | 1 | Yes | Yes | Yes | Ventilation off |
| Gym (rear) | | | | | | | | Teacher's workroom-3 photocopiers/1 lamination machine-no local exhaust |
| Kelleher | 1016 | 76 | 27 | 25 | Yes | Yes | Yes | Window open-2 windows do not stay open, univent diffuser |

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CT = ceiling tiles

Comfort Guidelines

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Temperature - 70 - 78 °F
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TABLE 3

Indoor Air Test Results – Hadley Elementary School, Swampscott, MA – March 6, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|-----------------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| | | | | | | | | blocked, 1 missing CT |
| Halloran | 940 | 73 | 24 | 19 | Yes | Yes | Yes | Dislodged CT-near hallway door, door open |
| School Nurse | 900 | 73 | 25 | 2 | No | Yes | Yes | |
| Art/Music | 802 | 72 | 27 | 18 | Yes | Yes | Yes | Window and door open |
| Basement Girls' Restroom | | | | | | | Yes | |
| Annex Hallway | | | | | | | | Recent leak-drain replaced-water damage |
| Berry | 514 | 70 | 26 | 0 | Yes | Yes | Yes | Window open, univent/exhaust-not functioning, window mounted air conditioner-fan mode-missing cover |
| Discovery Station Classroom | 567 | 73 | 27 | 1 | Yes | Yes | Yes | 5 occupants gone <5 mins. |
| CSS (communication-social-skills) | 740 | 75 | 26 | 1 | Yes | No | No | |

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CT = ceiling tiles

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 4

Indoor Air Test Results – Hadley Elementary School, Swampscott, MA – March 6, 2002

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|-------------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|---|
| | | | | | | Intake | Exhaust | |
| Kindergarten | 815 | 77 | 25 | 1 | Yes | Yes | Yes | |
| Lawler | 981 | 77 | 26 | 17 | Yes | Yes | Yes | 7 plants, window open |
| Speech & Language Room | 806 | 74 | 23 | 1 | Yes | No | No | Door open |
| Title 1 Math | 602 | 73 | 22 | 0 | Yes | No | No | Window open |
| Kindergarten/Clair | 630 | 72 | 24 | 1 | Yes | Yes | Yes | Plants/items on univent, 3 window mounted air conditioners-dust accumulation, window open |
| Kalpin/Office | 678 | 71 | 24 | 0 | Yes | No | No | |
| School Psychologist | 709 | 69 | 25 | 0 | Yes | No | No | Window mounted air conditioner |
| Health Office | 703 | 68 | 26 | 0 | Yes | No | No | |
| 3 rd Floor Hallway | | | | | | | | Historic water damage-leak reportedly fixed |
| Cafeteria | 628 | 68 | 33 | 0 | Yes | Yes | Yes | Exhaust fan reportedly not used |

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 5**Indoor Air Test Results – Hadley Elementary School, Swampscott, MA – March 6, 2002**

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---------------------------|------------------------|-------------|------------------------|----------------------|---------------------|-------------|---------|--|
| | | | | | | Intake | Exhaust | |
| Occupational Therapy Room | 565 | 67 | 30 | 4 | Yes | No | Yes | Univent not used-cobwebs in diffuser, reported musty odors in summer |

Comfort Guidelines

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CT = ceiling tiles

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 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%